FINAL

Main Proj. E-20-W70

NASA/CR-97- 205784

Sub Proj. #. E-16-N06

#1

ANNUAL SUMMARY OF WORK IN PROGRESS
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
FACULTY AWARDS FOR RESEARCH (FAR)

Award Number:	NASA Grant NAG3-1571
Principal Investigator:	Oliver G. McGee III, Ph.D.
Amount of Support:	$73,103 (FY#2)
Period of support:	February 15, 1994 to October 14, 1995
No cost extension:	October 15, 1995 to May 30, 1997
Date of request:	August 8, 1997
Requested Amount for FY#3:	$77,610
Proposed period of support:	October 1, 1997 to October 14, 1998
Project Title:	**Nonlinear Dynamic Analysis of Disordered Bladed-Disk Assemblies**

Summary of Ongoing and Future Research Effort

In a effort to address current needs for efficient, air propulsion systems, we have developed some new analytical predictive tools for understanding and alleviating aircraft engine instabilities which have led to accelerated high cycle fatigue and catastrophic failures of these machines during flight. A frequent cause of failure in jet engines is excessive resonant vibrations and stall flutter instabilities. The likelihood of these phenomena is reduced when designers employ the analytical models we have developed. These prediction models will ultimately increase the nation's competitiveness in producing high performance jet engines with enhanced operability, energy economy, and safety.

The objectives of our current threads of research in the final year are directed along two lines. First, we want to improve the current state of blade stress and aeromechanical reduced-ordered modeling of high bypass engine fans. Specifically, a new reduced-order iterative redesign tool for passively controlling the mechanical authority of shroudless, wide chord, laminated composite transonic bypass engine fans has been developed. Second, we aim to advance current understanding of aeromechanical feedback control of dynamic flow instabilities in axial flow compressors. A systematic theoretical evaluation of several approaches to aeromechanical feedback control of rotating stall in axial compressors has been conducted. Attached are abstracts of two papers [1,2] under preparation for the 1998 ASME Turbo Expo in Stockholm, Sweden sponsored under Grant No. NAG3-1571.

Our goals during the final year under Grant No. NAG3-1571 is to enhance NASA's capabilities of forced response of turbomachines (such as NASA FREPS). We will continue our development of the reduced-ordered, three-dimensional component synthesis models for aeromechanical evaluation of integrated bladed-disk assemblies (i.e., the disk, non-identical blading, etc.). We will complete our development of component systems design optimization strategies for specified vibratory stresses and increased fatigue life prediction of assembly components, and for specified frequency margins on the Campbell diagrams of turbomachines. Finally, we will integrate the developed codes with NASA's turbomachinery aeromechanics prediction capability (such as NASA FREPS).

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Summary of Ongoing and Future Research Effort (cont)

Full documentation of the proposed work (i.e., computer program modulation, and nondimensional tables, graphical charts, and visualizations of dynamical response information) in annual performance reports, NASA technical memorandums and reports, and journal articles will be the primary form of deliverables.

A final year timetable of effort is proposed.

Under the sponsorship of NASA Grant No. NAG3-1571 during fiscal year #2, the principal investigator attended one international conference, one continuing education international workshop in turbomachinery technologies. These include:

1. Turbomachinery Aerodynamics, Whittle Laboratory, University of Cambridge Program for Industry, University of Cambridge Board of Continuing Education, Cambridge, ENGLAND, June 1996.

2. ASME International Gas Turbine and Aeroengine Congress and Expositions, Birmingham, England, June 1996.

During the final year #3, the travel budget of the principal investigator includes a planned attendance to one international conference - the ASME International Gas Turbine and Aeroengine Congress and Expositions, Stockholm, Sweden, June 1998, and two visitations in the Fall 1997 and Summer 1998 to NASA Lewis Research Center in Cleveland, Ohio.

REFERENCES

1. McGee, O.G., and Fang, C., "Vibration Response and Flutter Control of Laminated Composite Transonic Bypass Engine Fans," *ASME Turbo Expo'98, Structural Dynamics Committee, ASME Journal of Engineering for Gas Turbine Engines and Power* (to be submitted, 1997).

2. McGee, O.G., Graf, M., and Frechette, L., "Theoretical Evaluation of Aeromechanical Feedback Control of Rotating Stall in Axial Compressors," *ASME Turbo Expo'98, Turbomachinery Committee, ASME Journal of Turbomachinery*, (to be submitted, 1997).